International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 7, Issue 1, Feb 2017, 241-246

EFFECT OF WEED CONTROL METHODS ON GROWTH, DRY MATTER ACCUMULATION AND YIELD OF MAIZE

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ABSTRACT

Maize (Zea mays), is the third most important cereal crop in the world after wheat and rice. Management of weeds is considered to be an important factor for achieving higher productivity as weed problem is more severe during continuous rains in early stages of maize growth which cannot be controlled by traditional and cultural practices alone due to too much wetness. The present study aimed to study the effect of different weed control methods on growth, dry matter accumulation and yield of maize. The experiment was conducted at Main Agricultural Research Station (MARS), College of Agriculture, Dharwad during 2014. Six herbicides were used in nine treatments using Randomized Block Design having three replications.T_8 (weed free check) was recorded significantly higher leaf area, dry matter production, grain yield and stover yield than all other treatments. The next best treatments were T_7 (Atrazine @ 1 kg ha^{-1} + 2 IC + 1 HW), T_4 (Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1}) and T_2 (Atrazine @ 1 kg ha^{-1} fbParaquat @ 1 kg ha^{-1}).

KEYWORDS: Weeds, Maize, Dry Matter & Leaf Area Index (LAI)

Received: Dec 24, 2016; **Accepted:** Jan 18, 2017; **Published:** Jan 21, 2017; **Paper Id.:** IJASRFEB201732

Original Article

INTRODUCTION

Maize (*Zea mays*), is the third most important cereal crop in the world after wheat and rice. In India, it is cultivated over an area of 9.43 m ha with a production of 24.26 m tonnes and the productivity is 2583 kg ha^{-1} (Anon., 2014). As far as Karnataka is concerned, it is cultivated in an area of 1.36 m ha with a production of 4.09 m tonnes and average productivity of 3018 kgha^{-1}.

Maize has attained a commercial crop status due to its ease of cultivation, tolerance towards pest and diseases, high yield and better market price. It is adaptable to wide range of soil and climatic conditions, still there is a lot of scope to increase the present maize yields. The yields can be increased with many agronomic manipulations. Management of weeds is considered to be an important factor for achieving higher productivity as weed problem is more severe during continuous rains in early stages of maize growth which cannot be controlled by traditional and cultural practices alone due to too much wetness.

The choice of weed control methods largely depends on effectiveness and economics. Due to increased cost and non-availability of manual labour in required quantity and time for hand weeding the use of pre and post emergent herbicides to manage the weeds play an important role. The herbicides not only control the weeds timely and effectively but also offer great scope for minimizing the cost of weed control, irrespective of the situation. Use of integrated approach would make weed control more acceptable to farmers which will not only change the existing agronomic practice but also will allow for complete control of weeds.

In order to control the weeds for longer period of the crop growth, there is a need for post-emergence herbicides on sequential basis for the control of weeds. Keeping the above facts in view, this study was taken up with the objective to study the effect of different weed control methods on growth, dry matter accumulation and yield of maize.

MATERIALS AND METHODS

The experiment was conducted at Main Agricultural Research Station (MARS), College of Agriculture, Dharwad which is situated at 15^0 29' N latitude, $74^0$59' E longitudes and at an altitude of 689 m above mean sea level and it comes under Northern Transition Zone (Zone-8) of Karnataka. Six herbicides namely Glyphosate, Paraquat, Glufosinate ammonium, Saflufenacil, Halosulfuronand Imazathapyr were tried as a post emergence in addition to pre-emergence application of Atrazine. Totally nine treatments were tested using Randomized Block Design having three replications.

During the experimental year (2014), rainfall of 962.20 mm was received which was 250.76 mm more than the normal.

Growth Parameters

Five plants from sampling area were randomly selected and observations on following growth parameters were recorded at harvest.

- **Plant Height (cm)**

The plant height was measured from ground level to the base of fully opened top leaf and expressed in cm.

- **Leaf Area Plant^{-1} (dm^2)**

Maximum length and breadth of leaves of the five plants were recorded. The product of length x breadth was multiplied by total number of green leaves plant^{-1} and the multiplication factor of 0.75 was used to calculate the total leaf area plant^{-1} as per the formula given by Sticker *et al.* (1961).

- **Leaf Area Index (LAI)**

Leaf Area Index (LAI) was calculated by using below formula given by Watson (1952).

$$LAI = \frac{\text{Leaf area per plant (dm}^2\text{)}}{\text{Land area occupied by the plant (dm}^2\text{)}}$$

Dry Matter Production (G Plant^{-1}) and Its Distribution

Five randomly selected plants from ring line through destructive sampling were used to record the dry matter production at 40, 80 DAS and at harvest. The sampled plants were oven dried at 65^0-70^0 C until constant dry weight was obtained. The total dry matter produced plant^{-1} was recorded.

Yield Components and Yield

The cobs from the five plants selected for taking growth observations were used for recording following observations on yield parameters.

- **Grain Yield (q ha^{-1})**

The cobs from the net plot were harvested at physiological maturity and they were dehusked. The dehusked cobs were air-dried and grains were separated from the cob by shelling and weighed the shelled grains after complete drying and taken as grain yield per plot. The grain yield was expressed in q ha^{-1}.

- **Stover Yield (q ha^{-1})**

Stover yield was recorded after complete sun drying of stalks from each net plot and expressed in q ha^{-1}.

- **Harvest Index (%)**

Harvest index was defined as the ratio of economic yield to biological yield and expressed in per cent. Harvest index was estimated as per the formula suggested by Donald (1962).

$$HI\ (\%) = \frac{\text{Economicyield (q ha}^{-1})}{\text{Biologicalyield (q ha}^{-1})} \times 100$$

RESULTS AND DISCUSSIONS

Growth Components of Maize

The growth components such as plant height, leaf area and leaf area index (LAI) at different stages of plant growth are presented in Table 1.

At harvest, T_8 (weed free check) was recorded significantly higher plant height (176.73 cm) whereas, significantly lower plant height (155.60 cm) was observed with T_9 (weedy check). T_4 (Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1}) was recorded on par plant height (171.47 cm) with T_8. Treatments such as T_7, T_2, T_1, T_3, T_5 and T_6 were found next in order of decreasing plant height however; these were superior to T_9 (weedy check).

T_8 (weed free check) was recorded significantly higher leaf area (16.84 dm^2 plant^{-1}) than T_9 (weedy check) (8.86 dm^2 plant^{-1}). T_4 (Atrazine @ 1 kg ha^{-1}fbSaflufenacil @ 75 kg ha^{-1}) and T_7 (Atrazine @ 1 kg ha^{-1} + 2 IC + 1 HW) were recorded higher leaf area (14.37 and 13.51 dm^2 plant^{-1} respectively) next to T_8. Treatments such as T_2, T_5, T_6, T_1 and T_3 were found next in order of decreasing leaf area.

The same trend was also followed in leaf area index (LAI). This was due to lower competition of weeds with the plants for moisture, light and nutrients throughout the growing season of maize as a result of lower weed population and lower weeds dry weight compared to other herbicides treatments. Similar results were also found by Patil (2014). At harvest, the plant height increased to the tune of 10 cm after 80 DAS due to internodal elongation in between the tassel and the cob. This might be due to sufficient moisture obtained through rainfall after 80 DAS. This result was found in line with the results found by Ishrat (2011).

Total Dry Matter Production (G Plant^{-1})

Total dry matter production (g plant^{-1}) of maize differed significantly with different weed control treatments at various crop growth stages (Table 2).

At 40 DAS T_8 (weed free check) was recorded significantly higher total dry matter production (50.60 g plant^{-1}) followed by T_7 (Atrazine @ 1 kg ha^{-1} + 2 IC + 1 HW) and T_4 (Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1}) which were recorded total dry matter accumulation 47.66 and 47.16 g plant^{-1} respectively. Treatments such as T_3 (Atrazine @ 1 kg ha^{-1} fbGlufosinate ammonium @ 0.375 kg ha^{-1}), T_2 (Atrazine @ 1 kg ha^{-1} fbParaquat @ 1 kg ha^{-1}), T_1 (Atrazine @ 1 kg ha^{-1} fbGlyphosate @ 2.5 kg ha^{-1}), T_5 (Atrazine @ 1 kg ha^{-1} fbHalosulfuron @ 90 g ha^{-1}) and T_6 (Atrazine @ 1 kg ha^{-1} fbImazathapyr @ 75 g ha^{-1}) were found next in order of decreasing total dry matter production. Significantly lower total dry matter production (39.14 g plant^{-1}) was observed in T_9 (weedy check).

At 80 DAS and harvest T_8 (weed free check) was recorded significantly higher total dry matter production. Significantly lower total dry matter production was recorded in T_9 (weedy check).Weedy check recorded lower dry matter accumulation in leaves due to lower number of leaves, leaf area and leaf area index which are important indices of plant that determines the photosynthetic ability, growth and dry matter production. Similar kind of results was also observed by Chougala (2013) and Singh *et al.* (2014).

Yield and Yield Components

Yield is the net result of various interactions *i.e.* soil characters, weather parameters, crop weed competition and various metabolic and biochemical interactions taking place throughout the plant growth. Maize grain yield is also influenced by dry matter accumulation in different parts especially in reproductive part and yield components.

Yield of maize varied significantly among various weed control treatments (Table 3). Significantly higher grain yield (84.59 q ha^{-1}) was observed in T_8 (weed free check) which was 87.68 per cent higher than weedy check (45.07 q ha^{-1}) followed by T_4 (Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1}) (81.38 q ha^{-1} which was 80.56 per cent higher than the weedy check).

Significant differences in stover yield (q ha^{-1}) was recorded with respect to different weed control treatments (Table 1). T_8 (weed free check) recorded significantly higher stover yield (114.10 q ha^{-1}) which was 71.83 per cent higher over weedy check (66.40 q ha^{-1}) and it was on par with T_4 (Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1}) having stover yield 109.80 q ha^{-1} (65.36 per cent higher over weedy check). The next best treatment was T_2 (Atrazine @ 1 kg ha^{-1} fbParaquat @ 1 kg ha^{-1}) which recorded stover yield of 102.10 q ha^{-1} (53.76 per cent higher over weedy check). Higher stover yield may be attributed to higher dry matter production and its accumulation in leaves, stem, reproductive parts and also other growth attributes such as plant height, number of leaves, leaf area, leaf area index. These results are in conformity with the findings of Ishrat*et al.* (2012) and Chougala (2013).

CONCLUSIONS

Atrazine @ 1 kg ha -1 fb Saflufenacil @ 75 g ha -1 as directed spray at 45 days after sowing (T 4) is found to be the best weed control method among all the herbicide treatments for rainfed maize because it is recorded higher grain yield, stover yield ,harvest index and all growth and yield attributing characters after weed free check.

Table 1: Growth Components as Influenced by Weed Control Methods in Maize at Harvest

Treatments	Plant Height (cm)	Leaf Area ($Dm^2 plant^{-1}$)	Leaf Area Index
T_1 - Atrazine @ 1 kg ha^{-1} fb Glyphosate @ 2.5 kg ha^{-1}(Directed spray)	167.73	10.88	0.90
T_2 - Atrazine @ 1 kg ha^{-1} fbParaquat @ 1 kg ha^{-1}(Directed spray)	170.30	13.69	1.13
T_3 - Atrazine @ 1 kg ha^{-1} fbGlufosinate ammonium @ 0.375 kg ha^{-1}(Directed spray)	167.63	9.66	0.80
T_4 - Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1} (Directed spray)	171.47	14.37	1.19
T_5 - Atrazine @ 1 kg ha^{-1} fbHalosulfuron @ 90 g ha^{-1} (Directed spray)	165.20	10.99	0.93
T_6 - Atrazine @ 1 kg ha^{-1} fbImazathapyr @ 75 g ha^{-1} (Directed spray)	164.80	10.26	0.85
T_7 - Atrazine @ 1 kg ha^{-1}+ 2 IC + 1 HW (RPP standard check)	170.73	13.51	1.12
T_8 - Weed free check	176.73	16.84	1.40
T_9 - Weedy check	155.60	8.86	0.73
S. Em±	1.12	0.67	0.06
CD (0.05)	3.35	2.01	0.17

IC: Inter cultivation **HW**: Hand Weeding **fb**: followed by

Note: All the above mentioned post-emergent (T_1-T_6) herbicides sprayed as directed spray at 45 DAS

Table 2: Total Dry Matter Production (G $Plant^{-1}$) as Influenced by Weed Control Methods in Maize

Treatments	Total Dry Matter Accumulation (G $Plant^{-1}$)		
	40 DAS	80 DAS	Harvest
T_1 - Atrazine @ 1 kg ha^{-1}fb Glyphosate @ 2.5 kg ha^{-1} (Directed spray)	42.50	255.00	277.65
T_2 - Atrazine @ 1 kg ha^{-1}fbParaquat @ 1 kg ha^{-1} (Directed spray)	43.16	266.96	284.56
T_3 - Atrazine @ 1 kg ha^{-1}fbGlufosinate ammonium @ 0.375 kg ha^{-1} (Directed spray)	43.38	258.55	277.46
T_4 - Atrazine @ 1 kg ha^{-1}fbSaflufenacil @ 75 g ha^{-1} (Directed spray)	47.16	279.68	296.09
T_5 - Atrazine @ 1 kg ha^{-1}fbHalosulfuron @ 90 g ha^{-1} (Directed spray)	42.22	260.33	277.24
T_6 - Atrazine @ 1 kg ha^{-1}fbImazathapyr @ 75 g ha^{-1} (Directed spray)	41.94	257.72	275.38
T_7 - Atrazine @ 1 kg ha^{-1} + 2 IC + 1 HW (RPP standard check)	47.66	263.56	283.00
T_8 - Weed free check	50.60	282.76	301.03
T_9 - Weedy check	39.14	243.12	252.88
S. Em±	0.73	1.77	1.84
CD (0.05)	2.20	5.30	5.51

IC: Inter cultivation **HW**: Hand Weeding **fb**: followed by

Note: All the above mentioned post-emergent (T_1-T_6) herbicides sprayed as directed spray at 45 DAS

Table 3: Grain Yield (q ha^{-1}), Stover Yield (qha^{-1}), Harvest Index (%) and Weed Index (%) as Influenced by Weed Control Methods in Maize

Treatments	Grain Yield (Q Ha^{-1})	Stover Yield (Q Ha^{-1})	Harvest Index (%)	Weed Index (%)
T_1 - Atrazine @ 1 kg ha^{-1} fb Glyphosate @ 2.5 kg ha^{-1}(Directed spray)	59.11	83.00	41.63	30.13
T_2 - Atrazine @ 1 kg ha^{-1} fbParaquat @ 1 kg ha^{-1}(Directed spray)	70.56	102.10	40.86	16.58
T_3 - Atrazine @ 1 kg ha^{-1} fbGlufosinate ammonium @ 0.375 kg ha^{-1}(Directed spray)	65.83	95.30	40.87	22.19
T_4 - Atrazine @ 1 kg ha^{-1} fbSaflufenacil @ 75 g ha^{-1} (Directed spray)	81.38	109.80	42.56	3.79
T_5 - Atrazine @ 1 kg ha^{-1} fbHalosulfuron @ 90 g ha^{-1}(Directed spray)	67.83	98.57	40.78	19.84
T_6 - Atrazine @ 1 kg ha^{-1} fbImazathapyr @ 75 g ha^{-1}(Directed spray)	62.67	91.30	40.70	25.92
T_7 - Atrazine @ 1 kg ha^{-1}+ 2 IC + 1 HW (RPP standard check)	68.17	94.67	41.86	19.41
T_8 - Weed free check	84.59	114.10	42.57	-
T_9 - Weedy check	45.07	66.40	40.45	46.75
S. Em±	0.68	1.63	0.34	0.88
CD (0.05)	2.05	4.87	1.02	2.63

IC: Inter cultivation **HW**: Hand Weeding **fb**: followed by

Note: All the above mentioned post-emergent (T_1-T_6) herbicides sprayed as directed spray at 45 DAS

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